KNOWLEDGE
AN ILLUSTRATED
MAGAZINE OF SCIENCE
PLAINLY WORDED—EXACTLY DESCRIBED

LONDON: FRIDAY, NOV. 2, 1883.

CONTENTS OF No. 105.

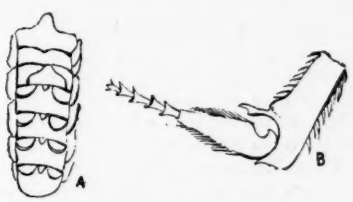
	PAGE
Pleasant Hours with the Microscope. By H. J. Slack	267
Strange Sea Creatures. By R. A. Proctor	268
The Birth and Growth of Myth. XIX. By Edward Clodd	269
The Himalayas and the Alps. II. By Colonel Godwin Austen	270
The Amateur Electrician. (*Illus.*)	271
Curiosities of the Sub-Tropical Garden	273
The Green Sun in India. By R. A. Proctor	274
Tricycles in 1883. By J. Browning	274
Pretty Proofs of the Earth's Rotundity. By R. A. Proctor	275
Munificent Employers	276
Correspondence: Sir William Herschel—Tricycles (An Error Corrected) — Large *v.* Small Wheels for Tricycles—Anthropometry—The Barn Owl—Large Sun-Spots—Letters Received and Answered	277
Our Mathematical Column	279
Our Chess Column	281

PLEASANT HOURS WITH THE MICROSCOPE.

BY HENRY J. SLACK, F.G.S., F.R.M.S.

THE longest, and in some respects most beautiful tongue, found in any bee belongs to the genus *Anthophora* (Mason Bees). *A. retusa* makes its nest in sandy banks and crevices of walls, and its mouth-organs are beautifully displayed when mounted in a fluid medium. I obtained a fine specimen from Mr. Baker, prepared by F. Enock. It is obvious that the relation of bees to certain flowers must be affected by the length of their tongues, and in this respect the Mason has a great advantage. The Common Hive Bee cannot get at the nectar of flowers which the Mason and the Ligurian Honey Bee are able to reach. The American authorities praise the Italian bees highly. Thus, Professor Cook, in his "Manual of the Apiary," says:—"They possess longer tongues, and so can gather from flowers which are useless to the black bee. I have seen Italians working on red clover. I never saw a black bee thus employed." Darwin noticed that the Hive Bee was as fond of the honey of the red clover as the Humble Bee, and often saw it sucking it through the holes in the corolla bitten by the latter insect. He also stated he had been assured that when red clover had been mown, the flowers of the second crop were somewhat smaller, and these were abundantly visited by Hivé Bees. "The fertility of the clover depends," as Darwin says, "on bees moving the petals, and if Humble Bees were to become rare it might be a great advantage to the clover to have a shorter or more deeply-divided corolla, so that Hive Bees should be induced to suck its flowers." As the Ligurian Bee is bred by some apiarists in this country, the Humble Bee may become a less important agent in fertilising this plant. The Italian Bee crosses with the Common Hive Bee, and perhaps some readers of KNOWLEDGE may have an opportunity of noticing whether the crossed variety possess the length of tongue belonging to the Italian race. This would be an interesting investigation, especially as Queen Bees have shorter tongues than workers, and so have drones. The mental characters of the common and of the Italian bee are reported to vary considerably. The latter are said to be more amicable to man, but fiercer to insect robbers who try to despoil them, and also to work earlier and later. Mr. Root, in his "A.B.C. of Bee-Culture," considers the hybrids equal in honey-gathering to the full-blood Italians, but he says "they inherit the boldness of the Italians and the vindictiveness of the blacks. Without any buzz or note of alarm, one of these sons of war will quietly dart forth and inflict his sting before you hardly know where it comes from; then another and another," &c. He also accuses them of being more disposed to rob than Italians, but not so much so as common bees.

A creature that leads so complex a life as a bee, has its habits determined by modifications of both external and internal organs. The Hive Bee requires wax, as well as honey, and this is produced by a special secretion. Mr. Root, in the work already cited, suggests a pretty experiment, that of feeding bees heavily on sugar syrup in warm weather, and at the end of the second or third day looking for the little pearly discs of wax that are newly-formed and protrude between the rings on the under side of the bee's body (A). He says they are objects of rare beauty under the microscope. The anterior legs of the bee are adapted



A.—Sketch of Bee's Abdomen, with wax plates protruding.
B.—Sketch of Bee's Fore-leg, with notch.

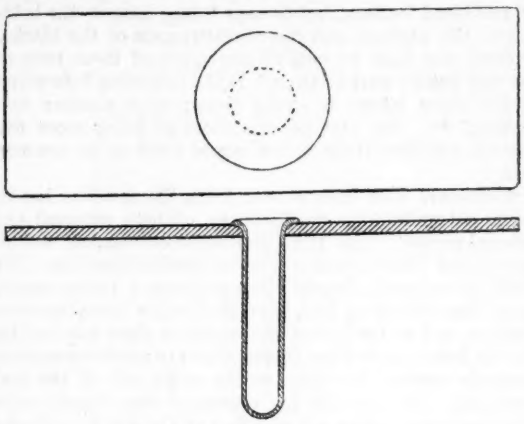
to seize these little wax cakes and convey them to its mouth, where it is kneaded with saliva.

To collect the pollen which is used in rearing the brood, the bee sweeps it from the plants with its tongue: its forelegs scrape it from the tongue. There is a little hollow in the leg, shown in the figure (B), and a finger-like projection opposite to it. Its tongue is said to be caught in the hollow, and when the leg is bent the projecting piece closes upon it. The pollen, moistened with honey and saliva, is conveyed by the middle legs to the hind pair, and stored in depressions somewhat miscalled "pollen baskets." They are little hollows easily seen with a hand-magnifier. Professor Cook speaks doubtfully about the function of the little notch in the foreleg of the working bee. He says, "For several years this has caused speculation among my students, and has attracted the attention of observing apiarists. Some have supposed that it aided bees in reaching deeper down tubular flowers, others that it was used in scraping off the pollen, and still others that it enabled the bees to hold on when clustering. The first two functions may belong to it, though other honey- and pollen-gathering bees do not possess it."

In the next paper the sting of the bee will be considered, as one of the modifications of an organ which has other shapes and uses in many insects belonging to the Hymenoptera.

To revert just now to another subject, the writer has been led to construct a tubular live-box, to facilitate showing the action of the blue-bottle's remarkable mouth-organs, and that of similar insects. It does not answer for bees. At this time of the year many large flies are driven indoors by the cold, and this little apparatus may assist in studying some of their interesting pecu-

liarities. When an ordinary live-box is used to hold a blow-fly captive, there is some difficulty in holding him tight enough, with the under side up, and yet



C.—Parts of Tubular Live-Box.

not so squeezed as to injure him, or interfere with his comfort. The tube live-box (C) is made with a small tube bottle, such as is used by homœopathic chemists, about an inch long and a quarter of an inch wide at the mouth. This is inserted into a hole cut in a wooden slide, and its rim prevents its falling through. Another wooden slide has a hole cut through it of rather larger diameter, and on the top side a thin glass cover is fastened with shellac glue. This slide is laid on the other. The glass cover forms a lid, which closes the tube bottle, and is held in its place by an elastic india-rubber band. A little cotton wool is put into the bottom of the tube to shorten the space, to suit the length of the fly, which must be inserted mouth uppermost, and kept moderately near the glass cover, upon which a drop of syrup is placed. Flies will readily feed in this position, and they are sufficiently limited in the power of lateral motion that they are easily kept in view with $1\frac{1}{2}$ inch or inch objective.

STRANGE SEA CREATURES.

By Richard A. Proctor.

THE Vicar of Bude reported recently the appearance of what he took to be some strange sea monster about a mile and a half from shore, near Bude Bay, travelling along at the rate of about twenty-five miles per hour (estimated). The object, whatever it was, was variously estimated at from 50 ft. to 80 ft. in length, which may be taken to mean that in all probability it was at least 30 ft. long. At one time a portion was so raised above the sea as to suggest that the monster was more like a serpent than a cetacean.

It is quite possible that the Vicar of Bude and those who with him saw this object were deceived by something which looked like a live sea creature, but was in reality not alive at all. In many ways such illusions have been produced. Some mass of floating seawrack, tossed by the waves into the semblance of life, may very well, at so great a distance as a mile and a half, have deceived the observers.

But it is well to notice that, although in numbers of cases objects taken for sea monsters have turned out to be inanimate masses, none of these interpretations of so-called sea-serpent stories can in the slightest degree negative the evidence obtained in such cases as that of the *Dædalus*, Government frigate, in which Captain McQuhae and his officers saw a sea creature unlike any known to science, travelling along against wind and sea, at the rate of twelve knots an hour, with the waves curling against its breast, and at a distance of less than 200 yards; so that, as Captain McQuhae puts it, a friend's countenance would have been recognisable at the distance. In several other cases the evidence has been equally decisive.

Then there have been other new sea creatures not at all like the supposed sea-serpent;—one, for instance, like a monster skate seen a few years back; another seen when the sea chanced to be exceptionally clear, crawling over the bottom of a bay on the Californian coast; and again, that singular sea monster seen in the Mediterranean a few years ago by the officers and crew of the *Osborne*, soon after a volcanic explosion had disturbed the sea bed there.

The fact really is that so far from the belief being absurd that creatures hitherto unknown exist in the depths of the sea, the wonder rather would be if men knew all, or even half, of the inhabitants of the ocean. It is astonishing how few of the denizens of the deep ever show themselves. In a sea journey lasting many weeks, one may see a shoal or two of porpoises, a whale or two, or the spouting of whales at a distance, a few sharks, flying-fish, and so forth, but not one in a million even of the sea creatures which during the voyage have been near the ship. For one sea creature which has occasion to come near the surface there are millions which never show themselves. I doubt if even half of the races of fish are known.

That there are marine creatures, also, other than fish, passing all their time beneath the sea surface, except when some occasional, and as it were accidental, circumstance may compel one of the race to come to the top, may be held to be absolutely certain. The doubts which have been flung on sea-serpent narratives, authenticated by responsible and reputable persons, are not scientific doubts, but the doubts of smatterers, who imagine that an air of doubt is an air of wisdom.

Quite probably none of the unfamiliar creatures taken for large serpents are serpentine at all. They may be long-necked creatures like the Dolichodeiros, or simply in some cases long-backed creatures like the Plesiosaurus, or they may have been in some cases only very large ribbon-fish. But to confound well-authenticated accounts such as Captain McQuhae's and those given by the officers of the *Osborne*, with the taradiddles told for their own amusement (and half the time without any expectation that they will be believed) by Yankee salts, is to make an egregious blunder.

Vice-Admiral Coles goes a little further. Because a particularly illusory sea-serpent which deluded some seamen in the British Channel turned out to be a long line of soot, from the sweepings of a steamer's dirty flues, he thinks he has found the reason not only for the Rev. Mr. Highton's sea-serpent, but for the whole brood. The *Dædalus* in the South Atlantic was *very* likely to be in the track of steamers' soot-sweepings.—*Newcastle Weekly Chronicle.*

THE large number of accidents occurring on American railways through carless crossing of the line, induces the *American Journal of Railway Appliances* (Sept. 15) to advocate prosecutions for recklessness, according to the English practice. It recommends that persons should be proceeded against for walking on the line, and jumping on and off trains in motion. Similar suggestions are made by other American papers.

THE BIRTH AND GROWTH OF MYTH.

By Edward Clodd.

XIX.

WITH the important exception of reference to the change effected in the Jewish doctrines of spirits, and its resulting influence on Christian theology, by the transformation of the mythical Ahriman of the old Persian religion into the archfiend Satan, but slight allusion has been made in these pages to the myths and legends of the Semitic race. Under this term, borrowed from the current belief in their descent from Shem, are included extant and extinct people, the Assyrians, Chaldeans or Babylonians, Phœnicians, Arabs, Syrians, Jews and Ethiopians.

The mythology of the Aryan nations has had the advantage of the most scholarly criticism, and the light which this has thrown upon the racial connection of peoples between whom all superficial likeness had long disappeared, as well as upon the early condition of their common ancestors, is of the greatest value as aid to our knowledge of the mode of man's intellectual and spiritual growth. And the comparisons made between the older and cruder forms underlying the elaborated myth and the myths of semi-barbarous races have supported conclusions concerning man's primitive state identical with those deduced from the material relics of the Ancient and Newer Stone Ages, namely, that the savage races of to-day represent not a degradation to which man has sunk, but a condition out of which all races above the savage have, through much tribulation, emerged. An important exception to this has, however, been claimed on behalf of at least one branch of the Semitic race—namely, the Hebrews or Jews. This claim has rested on their assumed selection by the Deity for a definite purpose in the ordering and directing of human affairs; a theory of the divine government which this journal is concerned neither to defend nor deny. No assumption of supernatural origin can screen documents of disputed authorship and uncertain meaning from the investigation applied to all ancient records; nor can the materials elude dissection because hitherto regarded as organic parts of revelation. The real difficulties are in the structure of the language and in the scantiness of the material as contrasted with the flexile and copious mythology of the Aryan race. And the investigation has been in some degree checked by the mistaken dicta of authorities such as M. Renan and the late Baron Bunsen; the former contending that "the Semites never had a mythology," and the latter (although any statement of his carries far less weight) that "it is the grand, momentous, and fortunate self-denial of Judaism to possess none."

But, independently of the refusal of the student of history to admit that exceptional place has been of direct Divine purpose accorded to any particular race, the discoveries of literatures much older than the Hebrew, and in which legends akin to those in the earlier books of the Old Testament are found, together with the proofs of historical connection between the peoples having these common legends, have given the refutation to the distinctive character of the Semitic race claimed by M. Renan. That a people dwelling for centuries, as the Hebrews did, in a land which was the common highway between the great nations of antiquity; a people subject to vicissitudes bringing them, as the pipkin between iron pots, into collision and subject relations to Egyptians, Persians, and other powerful folk, should remain uninfluenced in their intellectual speculations and religious beliefs, would indeed be a greater miracle than that which makes their literature inspired in every word and vowel-point. The remarkable collection of cuneiform inscriptions (so called from their wedge-like shape: Lat. *cuneus*, a wedge) on the baked clay cylinders and tablets of the vast libraries of Babylon and Nineveh, has brought out one striking fact, namely, that the Semitic civilisation, venerable as that is, was the product of, or at least, greatly influenced by, the culture of a non-Semitic people called the Akkadians, from a word meaning "highlanders." These more ancient dwellers in the Euphrates valley and uplands were not only non-Semitic, but non-Aryan, and probably racionally connected with the complex group of peoples embracing the Tatar-Mongolians, the distinguishing features of whose religion are Shamanistic, with belief in magic in its manifold forms. "In Babylonia, under the non-Semitic Akkadian rule, the dominant creed was the fetish worship, with all its ritual of magic and witchcraft; and when the Semites conquered the country, the old learning of the land became the property of the priests and astrologers, and the Akkadian language the Latin of the Empire."*

It was during the memorable period of the Exile that the historical records of the Jews underwent revision, and from that time dates the incorporation into them of legends and traditions which, invested with a purity and majesty distinctively Hebrew, were borrowed from the Babylonians, although primarily Akkadian. They are here, as elsewhere, the product of the childhood of the race, when it speculates and invents, framing its theory of the beginnings, their when and how; when it prattles of the Golden Age, which seems to lie behind, in the fond and not extinct delusion that "the old is better;" when it frames its fairy tales, weird or winsome, in explanation of the uncommon, the unknown, and the bewildering.

The Babylonian origin of the early biblical stories is now generally admitted, although the dogmas based upon certain of them still retard the acceptance of this result of modern inquiry in some quarters. That reluctance is suggestively illustrated in Dr. Wm. Smith's "Dictionary of the Bible," where, turning to the heading "Deluge," the reader is referred to "Flood" and thence to "Noah!"

So much for the legendary; but the analysis of the more strictly mythical, the names of culture-ancestors and heroes, sons of Anak and of God, scattered over the Pentateuch, is not so easy a matter. The most important work in this direction has been attempted by Dr. Goldziher,† but even his scholarship has failed to convince sympathetic readers that Abraham and Isaac are sun-myths, and that the twelve sons of Jacob are the zodiacal signs! Under the Professor's etymological solvent the personality of the patriarchs disappears, and the charming idylls and pastorals of old Eastern life become but phases of the sun and the weather. The Hebrew, like the Aryan myth-maker, speaks of the relations of day and night, of grey morning and sunrise, of red sunset and the darkness of night, as of love and union, or strife and pursuit, or gloomy desire and coy evasion. Abh-râm is the High or Heaven-Father (from *râm*, "to be high") with his numberless host of descendants. Yis-châk, commonly called Isaac, denotes "he who laughs," and so the Laughing one, whom the High Father intends to slay, is the smiling day or the smiling sunset, which gets the worst of the contest with the night sky and disappears. Sarah signifies princess, or the moon, the queen who rules over the great army glittering amidst the darkness. The expulsion of Hagar (derived from a root *hajara*, meaning "to fly," and yielding the word hijrâ or "flight," whence the Mohammadan Hegira) is the Semitic

* *Academy*, Nov. 17, 1877, p. 472.

† "Mythology among the Hebrews, and its Historical Development." (London: Longmans.) 1877.

variant of that inexhaustible theme of all mythology, the battle of Day and Night; Hagar flying before the inconstant sun and the jealous moon. And so on through the whole range of leading characters in Hebrew history; Cain and Abel, in which the critic overlooks the more likely explanation of the story as a quarrel between nomads and tillers of the soil; Jephthah, in which the sun-god kills at mid-day the dawn, his own offspring; Samson, or more correctly Shimshôn, from the Hebrew word for sun, the incidents of whose life, as expounded by Professor Steinthal,* are more clearly typical of the labours of the sun; Jonah and the fish, a story long ago connected with the myth of Herakles and Hêsionê; "as on occasion of the storm the dragon or serpent swallows the sun, so when he sets he is swallowed by a mighty fish, waiting for him at the bottom of the sea. Then when he appears again on the horizon, he is spat out on the shore by the sea-monster."†

These bare references must suffice to show that there is in Hebrew literature a large body of material which must undergo the sifting and the criticism which has been applied with success to Indo-European and non-Aryan myth. This done, the Semitic race will contribute its share of evidence in support of those conditions under which it has been the main purpose of these papers to show that myth has its birth and growth.

THE HIMALAYAS AND THE ALPS.‡

PART II.

LOMBARDY and the valley of the Po, with the southern side of the Alps, presents somewhat similar physical features. A large area of about the size of the north-west Punjab, once a part of the miocene sea, is occupied by a remnant of rocks of that age, considerably elevated and tilted, but not to such an extent as those of the Himalayas. Near Turin these dip towards the mountains, and a very short examination shows the undoubted glacial character of some of the beds; and as the whole formation is marine, their large, sharply-angular material, much of which is jurassic limestone, was probably transported from the adjacent mountains by the agency of ice in a shallow sea. After the great crushing and alteration of the previous outlines of the whole country, another sea filled the basin of the Po, and pliocene deposits were laid down in a sinking area extending to the base of the mountains all round the new bay or gulf. Re-elevation again set in, and with it, or soon after it, the advent of another and the last glacial period.

But the bounds of the pliocene sea extended even farther than the base of the mountains. At the south end of the Lago d' Orta, well within the hills sheltering under the isolated porphyry hill of Buccione, and 280 feet above the present lake (or 1,500 feet above the sea), I discovered this summer a patch of pliocene sand and clays with marine shells in excellent preservation. A thickness of sixty-four feet of the section is exposed, capped by moraine matter; its base was not seen, and the beds dip north. This remnant tells us a good deal. From where it rests there is a clear horizon to the north down the lake to the junction of its river with the Toce—unmistakable evidence that these beds must have extended far in this northern direction, and that long, fiord-like arms of the sea stretched up as far as Domo d' Ossola on one side, and Bellinzona on the other. This marine bed is far above the level of the Lago Maggiore, but I also found marine shells of pleistocene age 112 ft. above that lake near Arona. Before the last great elevation of the Alpine chain, the old line of sea-coast, therefore, ran even high up the long deep valleys of Maggiore, Como, Garda, &c., during the early pliocene period; the mountains then, quite as high as now, enjoying a warm moist climate, not a glacial one. Then came the gradual but uneven elevation of the whole area, including the miocene hills south of the Po, and lacustrine and estuary conditions prevailed over much of the plain country. The lapse of time was probably enormous, and as the land rose and the sea retired the climate gradually became cooler, and ushered in the glacial period. I do not think it would be an exaggeration to add another 5,000 feet to the Alpine peaks of that time, which would give them an altitude equal to the Zaskar range of the north-west Himalayas of the present day.

With the change and the increased volume of the mountain torrents, the destruction of the upraised marine pliocene beds commenced, and finally culminated in the extreme extension of the glaciers even into the plains. They scoured out almost completely the whole of these deposits, which then filled the great valleys and the country at the base of the mountains, to redistribute them again over the plain of the Po, and silt up what remained there of the old estuary or gulf towards the east.

The denudation of this formation has been enormous along the base of the Alps, and only mere remnants are to be found. It is easily seen that their preservation is purely due to the accidental position in places where the great denuding force—viz., the advance of ice from the mountains—has been unable to touch them; in other instances the early deposition of moraine matter upon them has acted like a shield, and prevented their entire destruction. Such examples are well seen near Ivrea, in the well-known section in the gorge of the Chieusella near Stombinella, and in the moraine near San Giovanni.

The scattered remnants of the pliocene formation south of the Alps, which took perhaps thousands of years to lay down, show well how soon a great formation, together with the preserved remains of the fauna living at the time, may be completely destroyed by subsequent denuding forces. Similar destruction must have occurred over and over again in past geological ages, and shows clearly how the scanty broken record can be accounted for. It is an established fact that the great valleys of the Alps and Himalayas existed much in their present form during miocene times, and they may owe their excavation partly to the glacial action of that period, when these mountain slopes rose from the plain or margin of the ancient sea, far in front of the present line of slope, and were far higher than now.

Depression has steadily continued in the delta of the Po, as in the Ganges at Calcutta, for at Venice borings showed depression of land surface to an extent of 400 ft., and they did not reach the base of the formation. It is not improbable that during the earlier extension of the glaciers into the Maggiore basin, the sea still had access to it; this would have greatly aided in the removal of the marine deposits, and then the deeper erosion of its bed near the Borromean Islands, so well put forward by Sir Andrew Ramsey.

When we see the gigantic scouring which glaciers have effected in the hardest rocks on the sides and bottoms of valleys, when we know for certain the enormous thickness they reached in the Alps, I do not doubt their capability of deepening a rock basin very considerably, or their power to move forward over and against slopes so low as 2 deg. to 3 deg. The earliest extreme extension of the glaciers was

* "Goldziher," pp. 392, ff. † *Ib.* p. 103.

‡ From the address by Col. Godwin Austen, president of the Geological section, British Association.

very great; we have evidence of it on the miocene hills near Turin, their surface being scattered over with transported material of great size, quite unconnected with that other ancient period of glacial conditions during the miocene times mentioned above at a period too remote to further dwell upon here.

An enormous interval of time must have elapsed, during which the cold was increasing and the glaciers advancing, and during which the rivers were distributing the consequent waste over the lower country, spreading out the more or less coarse material, sands and clays, in broad fans in front of all the great gorges. Then came the first period of contraction of the glaciers, with many oscillations. Of this we have the evidence in the moraines of Ivrea, Maggiore, &c. Sections of these moraines show how they are piled the one upon the other; how the building up of one line of lateral moraine was followed by its partial destruction on another forward movement of the ice and the throwing down of another moraine upon it. Then were formed many of the smaller lakes, remains of which lie amid the *débris* thrown out into the plain.

The glaciers retained this size for a very considerable time, and then apparently very rapidly retreated to far within the mountains; but still for another considerable period their dimensions were much larger than those of the present time, into which they seem to have again rather rapidly shrunk.

In the Himalayas we find ample evidence of a period of great extension of such conditions—first, in the erratics of the Attock plain and the Potwar, lying 50 to 60 miles from the gorge of the Indus at Torbela. We have again the fact that in Baltistan, in the Indus valley, glaciers have twice descended far beyond their present limits, first down to Scardo itself, and then to some 30 miles below their present limits; while the glaciers of Nanga Purbet, towering above the Indus some 22,000 feet, must have descended into the bed of that river. Cataclysms of the present time, caused by glacial obstructions, have raised the level of the Indus on the plain above Attock so much as 80 feet. When these glaciers were more than double their present size, gigantic floods must have often taken place, and formed boulder deposits high above present levels; such high level gravels are to be seen not only in the Potwar, but also in the Naoshera Dhun on the Rajurie Tawi River, containing boulders of nummulitic limestone and other rocks on the Pir Punjal on the north. Again, north of the Chatadhar ridge, small glaciers, five to six miles in length, at one time filled the lateral valleys, descending towards the Chenab River to about 5,000 feet; and a very perfect moraine occurs in one valley.

Examples of the former extension of glaciers are widespread along the chain of the Himalayas from west to east. True moraines, and moraine-mounds, at 16,000 feet on the north side of the Baralasa Pass, attest the presence of glaciers on the elevated plain of Rukshu, where now the snow-line is over 20,000 feet.

Whatever may have been the length of the glacial period in the Alps—and it was very considerable—in the Himalayas it cannot have been so long and so general, although, to a certain extent, contemporaneous. In the Alps glaciation meets the eye on every side, and the mountains, up to a distinct level, owe their form and outline to its great and universal extension. In the Himalayas it is difficult to trace polished surfaces or striæ markings, even in the neighbourhood of the largest glaciers that are now advancing in full activity. It has been suggested that obliteration is the result of more powerful denudating forces, but the conditions are not so very dissimilar in the high Alps and high Himalayas as to warrant this; and wherever the oldest striæ marks occur in the Himalayas, they are situated near the bed of the valley. The Baltoro Glacier would extend, if placed in the Toce valley, from the Simplon to the margin of the Lago Maggiore; or, to take another illustration of its length, from Mont Blanc to Châtillon in the Valle d'Aosta.

Although of such great length, these Himalayan glaciers could never have reached the enormous thickness which the earlier Alpine glaciers attained. This may thus be accounted for: in the European area a generally low temperature prevailed down to the sea-level, while in the Himalayan it was local and confined to a higher level. It is evident that the snow-line has altered—higher at one period, lower at another—down to recent times, denoting changes of the mean annual temperature which are not yet fully understood, but have been attributed to very far distant distribution or alterations of land, sea, and the ocean currents. Two periods of glacial extension are clearly defined, separated by a milder interval of climate; during the earlier glacial period the Indus valley was filled with those extensive lacustrine and fluviatile deposits, mixed with the large angular *débris*, such as we see at Scardo, which may be coeval with the extreme extension of the Alpine erratics so far as the miocene hills south of Turin. The second period followed, after a long interval of denudation of the same beds, and would correspond with the last extension of the great moraines of Ivrea, Maggiore, Como, &c., followed by a final retreat to nearly present smaller dimensions.

Nowhere on the south face of the Himalayas do we find valleys presenting any features similar to those of the Southern Alps, particularly on the Italian lakes, which are the result in the first place of marine denudation, succeeded by that of depression, and finally powerful ice-action. On the south face of the Khasi and Jaintia Hills, however, which are orographically connected with the peninsula of India—the conditions altogether different—we find long stretches of water of considerable breadth and depth extending within the hills, and not unlike in miniature the Italian lakes. These valleys, worn out of the sandstone and limestone rock, have been formed here, to some extent by the aid of marine action and the subsequent depression along this line of hills, also marked here, as in the Western Bhutan Doars, by the absence of beds newer than the nummulitic.

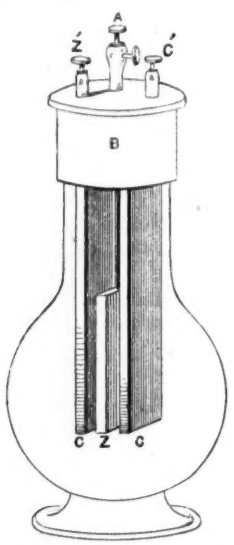
THE AMATEUR ELECTRICIAN.

BATTERIES.—V.

"PUZZLED" writes to say that he cannot understand the theory which asserts that in the simple cell (zinc and copper immersed in water) the hydrogen, freed by the combination of the zinc with the oxygen of the contiguous water molecules, deprives the next molecules of their hydrogen, and associates itself with their oxygen, and that a series of such exchanges takes place until the copper is reached. He wants to know why one molecule or pair of atoms of hydrogen should break up a molecule of water simply to replace the hydrogen originally pertaining to it. This is truly a ticklish problem to many. It has, I suppose, puzzled more or less every one who has given any attention to the subject, to a greater or less extent. The theory generally accepted is that hydrogen in its nascent condition (that is, at the moment when it is freed from combination) is more potent, that is more electro positive, than that hydrogen which is already in a state of combination, and that it is on this account able to displace it. A rough and perhaps a somewhat inconclusive method of demonstrating that the hydrogen freed at the surface of the

zinc is not transferred to the copper is to place a narrow cell in a lantern and send a powerful beam of electric or other light through it. Vigorous action will be seen on the zinc and copper surfaces, but between the plates all is quiet. There is no visible rush of hydrogen bubbles through the water. Electro-chemistry abounds with illustrations of this nature. There is an excellent one, for which we are indebted to the ingenuity of Davy. Three small glass vessels, such as watch-glasses, are filled with pure water, solution of syrup of violets, and sulphate of potash respectively. The centre one, containing the violet solution, is connected to the others by means of moistened asbestos or other threads. The positive pole of a battery is placed in the water, and the negative pole in the sulphate of potash. In a short time the water will become very sensibly acid. This acid must have resulted from the action upon the sulphate of potash. Furthermore, it cannot have passed through the violet solution in a free state, otherwise the colour would (in the ordinary way of chemical reaction), have been changed to red.

Bichromate batteries, to which we now direct our attention, or those in which bichromate of potash is used, are a very efficient and comparatively economical class. They are, perhaps, more closely allied to the Bunsen than to either of the other typical batteries. Zinc in all cases constitutes the positive, and carbon the negative element. The earliest forms were single-fluid batteries—that is to say, they had only one



solution in which both the plates were immersed. Fig. 1 represents a form known on account of its shape as the "Bottle" bichromate. It consists of a long and wide-necked bottle, with a brass collar, B, into which an ebonite cover, E, is fitted. A brass rod, A, passing through a hole in the cover carries a zinc plate, Z, which can by this arrangement be lifted out of the solution when the current is not required. The loss of zinc by local action is thus in a great measure prevented. Two carbon plates, CC, are fixed to the cover, one on each side of the zinc, and are connected by means of a brass strap on the ebonite, so as to form practically one negative plate so arranged as to call into use both surfaces of the zinc plate. Z′ is a terminal connected by means of a short brass strap with the small collar through which the rod A slides. C′ is a terminal connected to the strap joining the two carbon plates. Small insulating studs attached to the zinc prevent its making contact with the carbons, an eventuality which would obviously short-circuit the cell. The solution consists of bichromate of potash ($K_2Cr_2O_7$) and water, acidulated with sulphuric acid (H_2SO_4). The solution should be a saturated one—that is, it should contain as much bichromate as it possibly can. It is best in preparing the solution to apply heat, as the water then takes up an increased proportion of the salt. A pint of water will dissolve about three ounces of bichromate. When cool, four ounces of sulphuric acid should be added, and when the current becomes weak a further addition of four ounces of the acid will restore it. This latter remark, however, applies only to single fluid cells.

The action is somewhat complicated, and is furthermore accompanied by energetic local action. The zinc acting with sulphuric acid forms the customary sulphate of zinc ($ZnSO_4$), hydrogen being released. The bichromate of potash acting with other portions of sulphuric acid produces chrome alum ($2KCr2SO_4$), water (OH_2), and free oxygen. The free or nascent hydrogen combines with the free oxygen and forms water, thereby preventing to some extent the polarisation of the plates. The action may be represented by equations thus—

$$\left.\begin{array}{l} 3Zn + 3H_2SO_4 = 3ZnSO_4 + 3H_2 \\ K_2Cr_2O_7 + 4H_2SO_4 = 2KCr2SO_4 + 4OH_2 + 3O \end{array}\right\} 3OH_2$$

Or putting the two actions into one line we get—

$$3Zn + 7H_2SO_4 + K_2Cr_2O_7 = 3ZnSO_4 + 2KCr2SO_4 + 7OH_2$$

It will be seen by these equations that for every three atoms of zinc dissolved, and 7 molecules of sulphuric acid reduced, only 1 molecule of bichromate is affected. This is fortunate, on account of the comparatively weak solubility of the salt. The chrome alum forms with water, crystals of a violet tinge and of great beauty. They are, however, unwelcome guests, as they form chiefly upon the carbons and the containing cell, and considerably impair the cell's efficiency. Their formation, too, proceeds when the battery is lying idle. One of the prettiest objects throughout the range of battery products is a carbon plate covered with chrome alum crystals. When held up to the light, so as to allow the rays to pass through them, their beauty becomes at once apparent.

Very frequently the cells are made with several plates of carbon and zinc alternating, the carbons being connected to one terminal, and the zincs to another. This, of course, is equivalent to employing a large plate of zinc opposed to a large one of carbon. More of this, however, in our next article.

The battery is for some purposes very useful. It yields an electro-motive force of 2·0 to 2·12 volts, and is therefore in this respect more powerful than the Bunsen or Grove cells. Its resistance, too, is naturally very low, being but the fraction of an Ohm. It, however, very speedily loses its power, and the current dwindles away to nothing. Raising and lowering the zinc once or twice overcomes this defect for a time, and in experiments we have been able to obtain satisfactory currents, by adopting this device, for hours together, while one charging has sufficed to supply a current three hours a day, twice or thrice a week, for six months or more. It is apparent, however, that the longevity of a cell is limited by the consumption of its constituents. The bichromate cell is, nevertheless, very serviceable where strong currents are required for short intervals, and where the nitrous fumes arising from the Grove and Bunsen are objectionable. Upon this point we shall have a few words to say when speaking of the practical application of the bichromate in the form of the Fuller cell, of which, by-the-way, several thousands are at present in use.

CURIOSITIES OF THE SUB-TROPICAL GARDEN.

By Geo. G. Chisholm, M.A., B.Sc.

FEW more welcome additions have been made in recent years to the ornaments of our parks than those plants derived from sub-tropical regions which are now generally to be seen in greater or less abundance during that part of the year in which our climate permits of their flourishing. These sub-tropical additions are not always more splendid than the natives of our own islands or of other temperate climes, but they at least add variety and novelty to the aspect of our parks and gardens, and very frequently they strike us by the marked contrast of their forms when compared with those with which we are more familiar.

But our observation of these strangers from warmer latitudes is enriched with a deeper and wider interest when we do not content ourselves with looking at what any visitor may see from the walks, but take the trouble to know something about what strikes our eye. What are the uses, we may ask, of some handsome plant which we cannot help admiring? Where does it grow? Is it of any peculiar scientific interest? Has it any value in the arts, or does it yield anything to commerce? It will, no doubt, be worth while to answer a few such questions that may be put, let us suppose, by a visitor to the sub-tropical gardens of Battersea Park.

In those gardens, as in any similar gardens, at the present time there is one sub-tropical plant which is almost sure to attract our notice among the very first—the plant known to botanists as *Carma indica*, and often popularly termed Indian shot, from the appearance of its seeds. It will be seen in large beds, which can be distinguished even at a distance by the tall spikes of sometimes scarlet sometimes yellow flowers. On a nearer view one admires the plant not only on account of its handsome flowers, but also for their beautiful foliage, their large, elliptical, glossy leaves, with numerous parallel veins running on each side from the midrib.

From a scientific point of view, this plant is of no little interest, by reason of the peculiar structure of its flower. This flower has within the whorl of true petals another whirl of petaloid organs, which, from their mode of development, are shown to be modified stamens, or rather stamens which have not developed into their normal form, and have consequently remained barren. Within that again another whorl is represented only by a single fully developed organ, one-half of which at the top is in the form of an anther, while the remainder is petaloid. Usually this is stated to be a stamen, in which the filament and one anther cell have assumed a petaloid character, but it seems to have been shown by Dr. Dickie that it is in reality a stamen bearing a two-celled anther as usual, but united along its whole length to another petaloid anther.

On either view this flower is scientifically interesting as presenting an example of the assumption by one part of a flower of the form proper to another. Such changes are by no means uncommon in the vegetable world, and it was phenomena of this kind that first drew attention to the essential unity of type that characterises leaves, sepals, petals, stamens, carpels, and other parts of a plant. It was such phenomena to which Goethe pointed in his celebrated little treatise on the Metamorphoses of Plants, in which, it may be mentioned, the case of Carma is referred to.

If we turn to another part of the garden we may see another plant, which is not indeed sub-tropical, but which is interesting because it illustrates the same transition as Carma. Floating on the surface of the little lake which adorns the park, the blossoms of the white water-lily can hardly escape the notice of any visitor, and in these blossoms the passage from petal to stamen is shown in the most unmistakable manner. The parts of the flower in this case are arranged in a spiral round the summit of the axis, and the first appearance of a stamen is in the form of a minute portion of an anther pinching the top of a petal. Gradually as we pass inwards we find the antheriferous portion becoming larger while the petaloid portion becomes more and more narrowed, till at last in the inner turns of the spiral we find the change complete. The petals have got narrowed to the form of ordinary filaments which are surmounted by long anthers. The flower has typical petals and typical stamens, but it is impossible to say where the petals and stamens begin.

Let us look before leaving at another remarkable ornament of the gardens. In this case it is a tree, and the most striking thing about it is its large, pendulous, somewhat trumpet-shaped white blossoms, blossoms sometimes reaching twelve inches in length, though not in this country. This tree is one of those which are unfortunately known even to men of science by more than one name. Formerly it was called *Datura arborea*, a name still retained by many, and this name shows that it is a close ally of the thorn apple (*Datura stramonium*), which the old botanist Gerarde introduced into this country, where it now grows wild in many parts. It differs, however, from the thorn-apple not only in the arboreal habit to which it owes its specific name, but also in wanting those spines on the fruit which have earned for the British Datura its popular designation, and likewise in having that fruit only two-celled, whereas the Daturas proper have the fruit more or less completely divided into four cells or compartments. These differences have induced some botanists to refer this tree to a separate genus, to which they give the name of *Brugmansia*, which is again an unfortunate circumstance, inasmuch as that same name is applied by other botanists to another genus as different from that of which we are speaking as any genus of flowering plants could well be. Our Brugmansia, it should be mentioned, is a member of the potato family, and like the potato is a native of South America.

Amongst other interesting cases recently recorded of the good services rendered by the Westinghouse brake two in particular may be mentioned. On the 11th ult. an express train from Hull to Leeds, on the North-Eastern Railway, when running over fifty miles an hour was turned off the main line into a branch at Crossgates, near Leeds, by a blundering signalman. The brake was at once applied, and the train was coming to a stand, when in taking another pair of points it was thrown off the line, and separated into two or three portions; but, thanks to the automatic nature of the brake, each was separately stopped and no one was injured. The other case comes from the United States, and happened on the Baltimore and Ohio Railway. The *Chicago Tribune* says:—"Yesterday morning at the dawn of day, when the express, which is due in Chicago at 5.40 a.m., was about thirty odd miles from the city, and running at great speed, the engineer noticed smoke in front of him, and feeling a presentiment of danger, instantly applied the air brakes and stopped the train, loaded with its sleeping freight, just in time to keep it from plunging into the Little Calumet River. The bridge was burnt, and not over 30 ft. separated the locomotive of the train from the yawning abyss." The simplicity claimed for certain brakes would prove but a poor substitute for the quickness and certainty of the automatic brake in such cases as the above.

THE GREEN SUN IN INDIA.

By Richard A. Proctor.

FURTHER letters from Ceylon show that the green or blue sun was only seen there (at least as a marked phenomenon) from the 9th to the 12th September inclusive. The *Ceylon Observer* contains some interesting communications on the subject. One correspondent, writing on September 12 from Puleadierakam, states that no light came from the sun, though he was visible, until nearly seven in the morning. "For the last four days," he says, "the sun rises in splendid green when visible—that is, about 10 deg. from the horizon. As he advances he assumes a beautiful blue, and as he comes further on he looks like a brilliant blue, resembling burning sulphur. When about 45 deg. high it is not possible to look at the sun with the naked eye; but, even when at the very zenith" (meaning, no doubt, the highest point of his path, *near*, but not absolutely *at*, the zenith) "the light is blue, varying from a pale blue early to a bright blue later on, almost similar to moonlight even at mid-day. Then as he declines the sun assumes the same changes, but *vice versâ*. The heat is greatly modified, and there is nothing like the usual hot days of September. The moon, now visible in the afternoon, looks also tinged with blue after sunset, and as she declines assumes a most fiery colour 30 deg. from the zenith." It is rather singular that the moon when nearing the horizon should have assumed a fiery hue, while the sun, when in the same position, looked blue. This seems to show that though the moon looks white, there is really a certain degree of ruddiness in her surface tints.

As to the explanation of the changed tint of the sun, a few points are clear. It is obvious that the absorptive medium whose action gave to the sun its bluish-green tint was in our own atmosphere, not in the sun himself. As the sun was seen blue at Trinidad on September 2, it seems probable that the Java earthquake had nothing, or little, to do with the sun's peculiar tint in India and Ceylon; for the blue sun of Trinidad cannot possibly have been caused by the Java disturbance. The spectroscopic evidence seems to show that the greenness of the sun was due to an exceptional development of the rainband in the red part of the spectrum (the exact position of the band is shown in a diagram illustrating an article by Mr. J. Browning in Knowledge (No. 102, p. 230). Thus was occasioned an abnormal absorption of red and orange-red rays, leaving a superabundance of rays from the rest of the spectrum, and, consequently, a tint of green.

It is noteworthy that an explanation advanced in *Nature* (whose editor is supposed to know something about spectrum analysis) by Mr. W. R. Manley, principal of the High School of Madras, is entirely incorrect. He finds in the circumstance that the colour of the sum varied after the order of the colours of the solar spectrum, evidence that there was some refracting medium in the atmosphere which resolved the sun's rays into primary colours. This would not account for the sun appearing green. There is no sort of prism which will show the sun green, or blue, or red, let the refracting quality of the medium be what it may. Seen through any prism whatever the sun would simply show rainbow-tinted fringes on opposite sides of a central and not quite circular white disc. Absorption was manifestly the cause of the sun's colour, not simply refraction—though refraction, of course, took place (as it always does).

A correspondent calls attention to the circumstance that in the Arctic regions the sun often shines with a pure emerald-green tint all through the day.—*Newcastle Weekly Chronicle.*

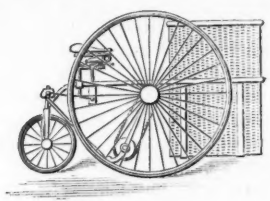
TRICYCLES IN 1883.

By John Browning,

Chairman of the London Tricycle Club.

THE "Carrier" just introduced by Messrs. Singer & Co. bids fair to bring the tricycle into still more general use in the business of everyday life. It is of very novel construction. Though a hind-steerer, it is a double-driver, both wheels working with one chain and a balance-gearing. The sides of the hay-fork frame are carried forward in front of the rider, and between them is suspended a large square wicker basket of a capacity of from forty to fifty cubic feet. The machine is contrived so that no more weight is thrown on the hind steering-wheel than is just necessary to ensure good steering.

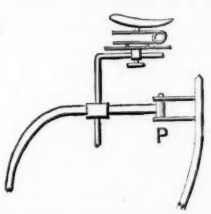
Evidently such a tricycle could be used with advantage instead of a horse and cart, to send out newspapers in bulk to the trade, or for the delivery of a number of light parcels. In country districts it would probably be service able to the Parcels Post.



The "Carrier."

The machine has wheels from 46 in. to 48 in. diameter, geared down to about 36 in. The value of such a machine would be increased tenfold if it were provided with a good two-speed gearing. The wheels should be 40 in., geared to run level. As it it necessarily a somewhat heavy machine, and will mostly be used in places of considerable traffic, it would not be required to be driven at a high rate of speed. The power-gearing should run at about 25 in. to enable the rider to work with a heavy load over muddy or rough roads, up hills, or against a high wind.

As the machine is now made I have driven it with great ease carrying between 160 lb. and 170 lb. in the basket on level ground.



The "Traveller."

The "Traveller" tricycle, brought out by the same firm, does not possess the same amount of novelty as the "Carrier," but it may prove of considerable value as a fast machine. It is a modification of the well-known "Humber," but the alterations are neither few nor unimportant. The double-driving-gear is reduced to about the size of a small tin blacking-box, being only about half the length of that on the usual "Humber." The pivots on which the front wheels swivel in steering (marked P on the block) are arranged in the form of a Stanley head, and are brought some distance behind the handle-bar towards the saddle of the rider. This, it is stated, diminishes the great

sensitiveness in steering so often complained of in the "Humber."

The saddle can be raised or lowered by means of an angle (⌐) seat-rod, which passes through the backbone; and the height of the handle-bar is also adjustable. These additions enable a man of any height to ride the same machine.

As far as I have been able to test the machine, I like it very much. Before long I hope to give it an extended trial over rough roads and up and down steep hills, and if I get satisfactory results I will report on them.

PRETTY PROOFS OF THE EARTH'S ROTUNDITY.

By Richard A. Proctor.

(*Continued from page* 147.)

I AM sorry that pressure of space has compelled me to defer so long the concluding papers of the present series, especially as many readers have expressed a strong wish that there should be no interruption. But it seemed only fair to my fellow-workers here to remember that at first these papers appeared on successive weeks, and that therefore this was the series to give way, when pressure came, and not those which are appearing fortnightly.

Only two points remain now to be considered, one an apparent difficulty, and the other a strange illustration of the earth's rotundity, which I noticed several years ago when travelling by rail over the plains of Western America.

The appearance which the earth presents when seen from a balloon is peculiar, and at a first view suggests anything but the idea of a convex surface such as a globe like the earth might be expected to present. The earth beneath the balloonist appears in fact like a gigantic basin, the rim of which is the horizon all round him, while its deepest part lies below him. Mr. Glaisher (I refer to the eminent meteorologist and aeronaut, not his logarithmic offspring, the Glaisher of Prime Factors, to whom the expansion of logarithms—Characteristic One—is of more interest than that of any balloon the world has yet seen) has spoken of this illusion, though of course he was in no sense deceived by it.*

Fig. 18 illustrates the peculiar effect in question; but I have added to the illusion affecting the aspect of the earth's surface another, equally marked and much more familiar, affecting the aspect of the clouds.

The explanation of both peculiarities is the same.

In my papers on Clouds and their Appearance I have shown how we are deceived into the idea that the clouds form a sort of dome over our heads, whereas the under surface of a layer of clouds, though slightly arched, is in reality very nearly flat within the range of view commanded by the eye. The eye is not sensible of the much greater distance separating us from the clouds near the horizon than from those overhead; and losing the effect of distance we picture the cloud-surface near the horizon as springing almost if not quite vertically from the earth's surface, to arch over, gradually at first and more rapidly afterwards, towards the point overhead. When we view the under surface of clouds from a balloon situated as shown in Fig. 18, a similar effect is produced.

But also, and for precisely similar reasons, a similar effect is produced on the appearance of the earth's surface below us. When we look directly down we see that the earth lies far below us, the greatness of the distance being very obvious and striking. On the other hand when we look towards the horizon, although the line of sight really is depressed slightly below the horizontal direction, the depression is not at all obvious, even when we are a mile or two above the sea-level.

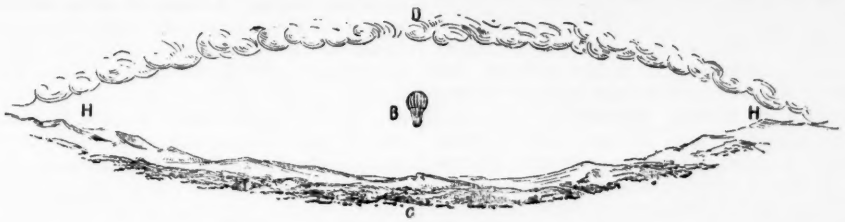


Fig. 18.

Say for instance we are even so much as two miles above the sea-level. Then from what has been already shown,

Fig. 19.

the depression of the visual horizon (suppose it to be a sea horizon) below the true horizontal direction, corresponds to the angle subtended by four miles at the distance where the line of sight from a height of 2 miles touches the sea level. This distance, neglecting refraction, which really increases it,* is represented in miles by $\sqrt{2 \times 8000}$, or by $\sqrt{16000}$, or by about 127 miles, and 4 miles at a distance of 127 miles subtends less than 2 degrees, which to the eye appears but an insignificant angle. Comparing unconsciously this slight depression of the horizon, with the obvious and startling depression of the earth's surface underneath his car, the aeronaut is deceived into the impression that the surface underneath rises up all around him to his own level or nearly so,—in other words the illusion of a basin-shaped depression such as is shown in Fig. 18 is produced.

* But the crafty Parallax, by quoting in his Zetetic Astronomy Mr. Glaisher's account of the illusion, without the sequent comments, cleverly leaves his readers, if he has any, to suppose that Mr. Glaisher thinks the earth may have a concave surface,—so that as the astronomer holds the earth to be convex while the aeronaut—thus misrepresented—holds it to be concave, the flat-earth folk feel justified in striking a happy mean and considering it to be as flat as flat may be.

* Taking it into account would strengthen the argument.

The real state of things is represented, only the earth's curvature is necessarily monstrously exaggerated, in Fig. 19, where b is the position of the balloon, $a\ c\ a'$ the earth's surface, c immediately below the balloon, $q\ d\ q'$ a layer of clouds parallel to the earth's surface. The lines $q\ p\ b$ and $b\ p'\ q'$ are tangent lines to the earth's surface, which they meet in the points p and p', while they meet the layer of clouds in q and q'.

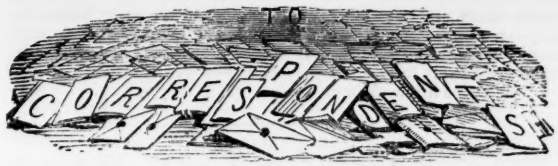
(To be continued.)

MUNIFICENT EMPLOYERS.

EIGHTEEN months have now passed since the great firm of Tangye Brothers was converted into Tangyes (Limited). The brothers Tangye still hold nine-tenths of the business, and the other gentlemen who had joined the firm had, with a single exception, been associated with Messrs. Tangye in the management of the business for many years before they became partners. The first annual meeting of the company was held at the Cornwall Works on Tuesday, and was constituted the occasion for the making of two important arrangements affecting the relations of the firms with their employés. It is well known that the firm have long desired to give some of the oldest foremen and workmen some slight interest in the business, but how this was to be done without conceding them all the rights and privileges of a large shareholder—a course which might be attended with serious inconveniences—was a difficult problem to solve. Messrs. Tangye have, however, at length initiated and adopted a scheme which is likely to work. It is this:—A certificate of indebtedness or bond of £50 is issued, setting forth that the holder is entitled to interest upon it at the same rate as the ordinary dividend declared by the company. The bonds have to be renewed at the end of each year, and in case the holder dies before the end of the year for which it is good his family is entitled to the value of the bond. Thus the bondholders enjoy all the pecuniary advantages of shareholders except that they cannot sell their shares; and they will be free from liability in event of bad times overtaking the concern. The families of bondholders coming under the formen's trust fund will receive £150 at the death of the holder, without having to contribute one penny towards it. An excellent provident scheme has also been formed for the benefit of all the workpeople. At the conclusion of the meeting of the company on Tuesday, Mr. R. Tangye delivered an address to about 1,300 of the operatives in explanation of the scheme. He remarked upon the amicable relations which existed between the company and their hands, and pointed out that for the past twenty-five years constantly increasing numbers of men, now aggregating thousands, had found regular and profitable employment at Cornwall Works. Rarely, indeed, had any workman been able to say that he left the works through slackness of trade. He hoped that at no distant date they would be able to extend their proposals for the workmen's benefit. If every man and boy would look at the property lying about the works as though it were his own, and resolutely set his face against its waste, the saving would enable the firm to give £50 to the family of every man dying in their employment from natural or any other cause. We do not often meet with a firm taking more care of their operatives. Mr. Tangye, in his address, stated that special precautions have been taken for dealing with accidents. "After this date the family or friends of any one who may unfortunately meet with a fatal accident whilst working for us, or, who from injuries received while working for us shall be unable to work, will, in the former case, receive a sum of money, and, in the latter case, a weekly sum, upon the following scale, without contributing a penny towards it:—In case of death, the friends of youths receiving weekly wages of 17s. or under will receive £25. Men with weekly wages between 17s. and 24s., £50; between 24s. and 30s., £75; and above 30s. per week, £100. In case of disablement, youths with weekly wages of 17s. a week or under, 5s. per week; men with weekly wages between 17s. and 30s., 10s. per week; and those above 30s., 15s. per week. I need hardly remind you that under the Employers' Liability Act, in case of an accident, a workman has no claim for compensation when it can be shown that he has contributed to the accident by his own fault; but we shall make no difference in that respect. The money will be paid in any case, but if you accept our proposal it will be only reasonable that we shall be exempted from any further liability. I want to explain to you that in the course of a few days every person on the ground will be asked whether he agrees to these proposals. He will have to sign in the same way as you sign now for permitting the office to deduct the dispensary money from your wages. If he accepts them, we shall be exempted from any further demand, because, obviously, it will not be fair for the same person to pay twice for the same thing. It will be in no degree obligatory on any one to sign his acceptance of those proposals. I hope the first result of these proposals will be to cause every man who is not in a club to at once join one." Finally, Mr. Tangye announced that the firm were going to give £1,000 to buy a piece of land on which to build baths and washhouses, and a similar donation to Mr. Jaffrey's hospital.—*Engineer.*

MR. DARWIN ON THEISM AND EVOLUTION.—This week the *Pall Mall* quotes the following letter from Charles Darwin, which appears in a work just issued:—"Dear Sir,—It seems to me absurd to doubt that a man be an ardent Theist and an Evolutionist. You are right about Kingsley. Asa Gray, the eminent botanist, is another case in point. What my own views may be is a question of no consequence to any one but myself. But, as you ask, I may state that my judgment often fluctuates. Moreover, whether a man deserves to be called a Theist depends on the definition of the term, which is much too large a subject for a note. In my most extreme fluctuations I have never been an Atheist in the sense of denying the existence of a God. I think that generally (and more and more as I grow older), but not always, that an Agnostic would be the more correct description of my state of mind.—Yours faithfully, CH. DARWIN."

STARTLING SCIENTIFIC STATEMENT.—In *Tit-Bits* the following instructive reply appears:—"A. L. D. We have tried the experiment of dropping a stone from the carriage-window whilst the train is in motion. We find that directly the stone has left our hand it loses the forward motion which it had whilst carried by the train, and being acted on only by gravity, it falls in a direct perpendicular line to the ground, and, consequently, when it touches the ground our hand is not directly over it, but is some little distance in front, varying with the speed at which the train is travelling. Perhaps, in performing your experiment, you have considered the words 'left behind' to mean that the whole body of the train has passed the stone before it touches the ground. The words were not intended to convey that impression. The stone is left behind the spot or part of the train from which it was dropped. We trust this explanation will make the matter clear to you." Galileo, Newton, and observed facts wrong after all!



"Let Knowledge grow from more to more."—ALFRED TENNYSON.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

All Editorial communications should be addressed to the EDITOR OF KNOWLEDGE; *all Business communications to the* PUBLISHERS, *at the Office, 74, Great Queen-street, W.C.* IF THIS IS NOT ATTENDED TO DELAYS ARISE FOR WHICH THE EDITOR IS NOT RESPONSIBLE.

All Remittances, Cheques, and Post Office Orders should be made payable to MESSRS. WYMAN & SONS.

The Editor is not responsible for the opinions of correspondents.

NO COMMUNICATIONS ARE ANSWERED BY POST, EVEN THOUGH STAMPED AND DIRECTED ENVELOPE BE ENCLOSED.

SIR WILLIAM HERSCHEL.

[982]—With reference to letters 947 and 956, as to the statement by "A Fellow of the Royal Astronomical Society" that Sir William Herschel lost an eye observing the sun, I beg to point out that in Webb's "Celestial Objects" (3rd ed., p. 19) it is stated that "Galileo probably thus blinded himself wholly, and Herchel I. in part." A. H. S.

[In Smyth's "Bedford Cycle," Vol. I., p. 87, it is stated that Sir W. Herschel lost the sight of one eye in this way.—R. P.]

[983]—On my return home I lose no time in redeeming the promise to Colonel Herschel, given by me in Letter 956, p. 233. If, then, he will turn to p. 87 of Vol. I. of Smyth's "Celestial Cycle" (the "Prolegomena" to the "Bedford Catalogue") he will find its author saying, apropos of observing the sun:—"Nor is it wholly without danger. The illustrious Sir William Herschel lost an eye in this service, and I myself had a narrow escape from a similar disaster, by neglecting to reduce the aperture of the instrument." As Admiral Smyth was 34 years old at the time of Herschel's death, he may well have seen him face to face. Whether, though, he wrote the words I have quoted from personal knowledge, or from hearsay, I have no means of deciding.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

TRICYCLES (AN ERROR CORRECTED).

[984]—In No. 103, page 241, it is stated that Messrs. Larrette and Barrow rode on a tricycle 18 miles in 25 minutes. That would be at the rate of 43⅕ miles an hour. It is probable that 1 hour and 25 minutes is meant. That is (circa) 12¾ miles an hour.

JAMES MONTAGUE.

LARGE *V.* SMALL WHEELS FOR TRICYCLES.

[985]—I have read with considerable interest the correspondence upon this subject now publishing in your paper. There is, however, one question, and that the most important of all—safety—which both parties appear to have entirely overlooked. Increased speed is a very good thing, but it is not worth purchasing at the cost of increased risk of accident. I am now fast approaching sixty years of age, weigh considerably over fifteen stone, and have just returned from a run through Gravesend, Ramsgate, Dover, St. Leonards, Eastbourne, Brighton, Worthing, Portsmouth, Southampton, Winchester, Reading, Slough, and through Watford back into Hertfordshire.

I ride for health, exercise, and recreation, and to me speed occupies a very secondary place in comparison with safety. I ride a 50-inch Sparkbrook National, geared to 48 inches, or nearly level. When I am in the saddle my pedals have 4½ inches clearance, and my saddle is 37 inches from the ground, or 12 inches above the axle. The centre of gravity being so low, my weight acts as ballast, and the chances of an upset are very small indeed, so that I can turn even sharp corners with safety. Place me upon a machine with 36-inch wheels and my saddle will be exactly on a level with the tops of the wheels, and my weight, so far from serving as ballast to steady the machine, would in that elevated position simply tend to overthrow it. This fact alone is sufficient to condemn small wheels in my estimation. I shall be glad to hear from Mr. Browning what is his opinion upon this, to me, all-important point. W. W. D.

[986]—In view of the letters and articles which have lately appeared in KNOWLEDGE upon the subject of "Tricycle Wheels," perhaps I may be allowed a little space for the same subject.

A small machine geared to two speeds has these advantages, (1), lightness; (2), ease in climbing hills. Having small wheels which run round faster, the machines have the disadvantage of greater friction. The supporters of large wheels urge in their favour, (1), less friction; (2), more comfortable riding on rough roads. The opponents say that large wheels have the disadvantage of (1) greater weight, and (2) less adaptability to hill riding except by gearing down.

Now, the question is, taking all the pros and cons for each side, which is the best machine? that is, which gives the greatest possible speed with the least possible fatigue? We often wonder how there can be any diversity of opinion on this point, considering that there are so many tricyclists capable of judging. But, the fact is, each tricyclist can only judge of the particular machine or machines he has ridden, and very few men who hold opposite opinions are riding machines by the same maker. Besides this, one might add that what suits one man may be most unsuitable for another. One could hardly expect a man "born almost without muscles" to ride a large and heavy machine, but one can partly understand a strong rider like "Sigma" having a contempt for "geared-up castors."

However, the few considerations which follow may help to guide any one who has not ridden to the choice of a machine suitable to himself.

Consider first the small wheels geared high. The first advantage—viz., lightness—is so obvious, that I need hardly mention it. Although we cannot say that the weight of the wheel varies as its diameter, we can say small wheels are lighter than large ones. Now, on hills the weight of the machine is an important consideration, and tricycle riders in general will certainly "go for" anything which takes off the weight without lessening their speed. The convenience of changing gear for hills applies more to weak than to strong riders, but even to strong riders it is of importance for very steep hills. Much has been said of the connection between the "dead point" and hill-climbing. Some have asserted in KNOWLEDGE that the "dead point" occurs more frequently with small wheels than with large ones. It does not. The dead point has only to do with the pedals. It is the point where one pedal is up and the other down, and therefore no power is being applied. But if a machine with small wheels is geared up to the same speed as one with large wheels, that means that the pedals of both machines are going round at the same rate. The small geared wheels move round faster than large ones, and thus more friction is caused. This is a cause of complaint that will lessen every year, for ball-bearings are being continually improved. Still the fact remains that in small wheels geared up and having the most perfect bearings, the friction is greater than in large wheels. But is this not compensated by the less weight of the small wheels? In hill-climbing the large-wheeled tricycles may be geared down, but there is still the extra weight of the wheel.

The last point in favour of the large wheels is that of comfort. On rough roads there is no doubt that large wheels go more smoothly, and with less jerking over stones or similar obstacles; but in England the roads are generally speaking good, and by thick rubber tires we can take away much of that inconvenience.

Leaving this for the consideration of your readers—that is, if you choose to insert it, THOMAS B. WALKER.

ANTHROPOMETRY.

[987]—In reply to "Hallyards" [970] I would say that the conclusion as to tallness or shortness being a racial peculiarity is due to the Anthropometric Committee of the British Association, and not to myself. At the same time, if a humble outsider may say so without presumptuousness, I fully concur in their conclusion. Races of men *do* differ noticeably in height, *e.g.*, Japanese and Patagonians, Finns and Swedes, Bushmen and Zulus, Esquimaux and Red Indians. Increased food and ease of life no doubt tend to make individual members of each race attain the highest development of that race, but they do not, apparently, tend to make Japanese (for example) grow as tall on the average as lowland Scots, unless (perhaps) the favourable conditions be extended over a very long space of time, and (probably) be accompanied by special selective action, sexual or natural. If "Hallyards" will read the Report of the Anthropometric Committee, and also the writings of Dr. Beddoes, Dr. Thurnam, Prof. Rollestone, and other ethnologists, he will, probably, be convinced that size and shape of bone is a remarkably constant racial feature, and he may, perhaps, be surprised to find how wonderfully such small personal peculiarities often persist from generation to generation.

As to "Hallyards'" two particular examples, I should like to ask him, first, how does he know that the Lowland Scots

XUM

of the coast are "identical in race" with Lowland Scots of the interior? I should have thought the historical probabilities were all the other way. On the east coast, the blood in all likelihood is mainly Anglian with a slight Scandinavian admixture; on the west coast, we know that Galloway was Pictish, while Strathclyde was Cymric; and there is no proof that the Celt was ever here displaced: inland, it seems to me probable, that there would be a larger survival or intermixture of the still earlier Neolithic race, who were doubtless driven from the east coast by the conquering Teuton, and from the west coast by the Pict and Cumbrian. Of course, all this is very problematical; but at any rate, in a case where we know that at least four, and probably five, races are involved, I don't see how we can speak confidently about "identity" of blood. And, secondly, as to Tipperary, I know nothing myself at first hand about the facts; but I have been told (I can't say whether on good authority) that two-thirds of the Tipperary peasant-farmers are the descendants of Cromwellian soldiers, in which case they ought certainly to be of different race from the Celts of Kerry, the Northmen of Cork, or the Neolithic people of some scattered Irish regions. Perhaps somebody who understands Irish ethnology will kindly give us some information as to the Tipperary men. GRANT ALLEN.

THE BARN OWL.

[988]—No doubt Kerry Rix [968] is quite right in his statement that barn owls do occasionally feed on young game birds, though I have never met with an instance to that effect in my own experience. Still, such cases are very exceptional, and as a whole, the owl must be looked upon as the farmer's friend, from the vast quantity of rats, mice, and other small mammals that he destroys. Dr. Altam examined 706 pellets of the barn owl, and found in them the bones of various animals in the various proportions:—Shrews, 1,590; voles, 693; mice, 237; rats, 3; bats, 16; birds, 22. Colonel Irby, who has investigated the question very carefully, says, "Old birds they have not the power to kill, and young pheasants and partridges, at the time the owls are on the feed, are being safely brooded by the parent birds." Kerry Rix will find a full discussion on the subject in Mr. Bowdler Sharpe's article "Birds," contributed to Professor Martin Duncan's "Cassell's Natural History," vol. iii., p. 306, &c. That owls will eat young pheasants reared by hand I can readily believe: no doubt they will eat anything they can catch: but, on the whole, they certainly do more good than harm, from a strictly human point of view. What the mice and shrews think of them is quite another question. GRANT ALLEN.

LARGE SUN SPOTS.

[989]—I see in to-day's KNOWLEDGE, illustrations and descriptions by "Vignoles" (letter 964), of some very large sun spots visible about Oct. 11 and 12. I had not an opportunity of observing the sun on those days, but on turning my telescope towards him on Monday last, Oct. 15, a beautiful sight rewarded me, for there were three very fine groups of spots, or, besides many other smaller spots, two of the groups being near the western edge. On procuring my ever-ready piece of smoked glass, I found that two of the groups, the one near the eastern edge and one of those near the western edge were distinctly visible to the unaided eyes, each as a single spot of course.

I do not remember ever to have known two spots visible to the naked eye at the same time before, and I see that "T. P. B." (letter 962), in to-day's KNOWLEDGE, makes a similar statement, but as he refers to spots visible on Oct. 11, one of them could not be the same that I saw on the 15th, for one of those I saw was only just coming on at the eastern edge when I saw them, and so could not have been visible on the 11th at all; therefore it would appear that there were three spots visible to the naked eyes within a space of four days, a circumstance totally unprecedented, as far as I know, and giving striking evidence of the awful nature of the disturbance taking place on the sun's surface (if I may so term it) at that time.

On Tuesday, Oct. 16th, I again examined the sun through my smoked glass, and found the spot near the western edge no longer visible to the naked eyes, being carried too near the edge by the sun's revolution, while, of course, the same revolution had brought the one near the eastern edge more fully into view, and it was proportionately more distinctly visible, and I again observed it in the same way on the two following days; but on the 9th the sun was entirely obscured by clouds, so that I had no opportunity of looking for the spot.

While writing I would like to suggest to "F.R.A.S." that he might include in "The Face of the Sky," for the benefit of amateur astronomers, some information as to the position, &c., of comets when there are any visible, as I think they are very interesting objects to watch, and I understand there have been two small ones visible recently, yet he has never so much as mentioned them, although I think he will not deny that they would interest many if he would give a few plain hints as to where they might be found.

EXCELSIOR.

THE HANGMAN.

[990]—Thank you for your courtesy. I think it was about two years ago that I read in some newspaper how Marwood, when passing through part of Ireland on his way to discharge his duties in the case of some rebel convicts, was reviled and threatened by some Irishmen who recognised him, and who also knew what was the object of his journey. A lady in the train, seeing that he was in some danger, and sympathising with the justice of his mission rather than with Fenianism and Phœnix Park atrocities, entered his carriage and sat beside the threatened executioner for the rest of his journey, in order to throw the ægis of her protection, whatever it might be worth, over him. When I read this I admired and most heartily sympathised with this lady. Evidently she, like myself, viewed the work of an executioner as a necessary and just, and therefore a fully-justified if not praiseworthy, work—all the more praiseworthy considering the cloud of degradation which is cast over both the office and the man by sympathy with crime in some cases and superficial prejudice in others. She clearly did not, as you as clearly do, attribute bad motives to every occupant of the office.

If from the fact that the executioner takes life, it necessarily follows (as you assume to be the case) that he *delights* [I used no such expression, but the mistake is of a piece with the rest.—R. P.] in taking life, how about the *Judge* who sentences the criminal to death? And the *Sheriff*, with whom the responsibility of the executions primarily rests? And the *soldier*, who is sometimes the agent of homicide even in an unjust cause? Do we—will you—impute bad motives to all of these? And why not to these, if to the executioner. Is there any proof that even one executioner has loved killing *as* killing? Yet would it not be wonderful if executioners were men of degraded disposition! For what is so likely to debase the tone of a man's mind as the belief of all his neighbours that he is already debased? To me it seems equally unscientific and illogical to impute motives in the sweeping way you do, and yet offer no proof beyond assertion.

E. D. GIRDLESTONE.

[The office of the Judge is quite as much to see that the innocent shall not suffer as that the guilty shall. *The hangman's is the one office where the sole duty is to take life.* In none other is it even the chief duty. So long as there is no difficulty in finding hangmen none need take the office as a matter of duty. In these points will be found a full and sufficient answer to the above reasoning.—R. P.]

INSANITY AND CRIME.

[991]—In a leader (Oct. 20) on "Insane Criminals," experts in diseases and derangements of the brain are decried by the *Times* as mere theorists, and termed "inventors of a *quasi*-scientific terminology and jargon. It is forgotten that the law, in dealing with responsibility in criminals, has come down to us from a time when the densest ignorance prevailed on the relation of mind and body. And if now but imperfectly understood, there are at least certain data which may be regarded as affording a reliable basis on which to work, and the fact that the treatment of insane patients is so far more successful than of old, is a sufficient proof of the advance of scientific truth. The position of science on the subject, up to which the public mind, *pace* the *Times*, is being gradually educated, briefly stated, is clearly this: Mind is a function of the brain, and not an entity independent of the organisation. Our tendencies are congenital and hereditary; we are, in fact, what our ancestors have made us, leaving, of course, a margin as to the direction of development according to the conditions of our lives. And the result of the scientific position is that when a crime is committed for which no adequate motive can be assigned, and there is found to be (as, indeed, is almost invariably the case) brain disease in the family of the criminal, the presumption is that the criminal inherits the insane *neurosis* in some form or another. If this be *truth*—and it would be hard to refute it—it is useless to meet it by the abuse and ridicule of scientific men. All truth is sacred, and therefore, instead of quailing before it, or crying out in anger when new truth presents itself, the only thing to do is to revise one's notion of the situation. Society must be protected, and who can doubt that it will be? But it is mere twaddle to talk of the common sense of the law and of juries, on a question respecting which a safe judgment can be formed only by a knowledge—not of theories—but of physiological facts. H. A. BULLEY.

LETTERS RECEIVED AND SHORT ANSWERS.

ALEX. A. RODGER. Your contempt for "Vegas and John Fiskes," *et hoc genus omne*, must extend to and include me also. Can you not see that the God they speak of is but a symbolisation? They advance no dogma, would force no ideas about the nature of Deity on men unwilling to accept even the thought of deity. But the freedom of thought about which you are so earnest is a strange sort of freedom if it means that they or I or any who think as we do, are to be silent because there are some who can stand face to face with the mighty mysteries of the universe and not feel that at the back of those mysteries there lies a greater mystery yet, the mystery of the Infinite Unknown, "yea evermore Unknowable," but as manifestly *there* to us as the sun is in the mid-heaven even when his light so blinds us that we cannot see him because of his very glory. If our widening recognition of the infinite extension of the universe alike in space and time, our clearing perception of the infinite range of the laws of the universe, the mystery of universal gravity, the mystery of eternal evolution, are to lead to the belief that *there* within the region of the known lies all, then were it better—so far as the worth of life is concerned—that no advance towards wider knowledge should ever have been made. But as reasonably might the student of some complex mechanism, who had traced a few links of the connecting chains or watched the movements of some half-dozen cogs, pretend that the whole plan and purpose of the machinery was known to him, the whole scope even of the mind and character of its constructor. I have no wish to convince you that your view of the universe is narrow and unworthy. But in common honesty I must tell you that if you or any other readers of KNOWLEDGE suppose my refusal to admit religious discussions into these pages involves the rejection of all reference to a Power outside the known, and working (unknowably by us) in and through all things, then you labour under a considerable delusion. You speak of freedom of thought, by the way; but the contempt and rancour you express are altogether inconsistent with real freedom.—B. WALKER. *You* enter *another* debatable region. You speak, however, of feelings of rancour and animosity which do not exist. Most students of science simply do not concern themselves with the questions you raise. I have mixed a good deal with them, and I know that it is so. You might as reasonably talk of the feelings of rancour and animosity entertained by fishermen towards land-surveyors, or by any class of men towards another class in whose pursuits they happen to take no special interest. Do you imagine that when Mr. Allen speaks of the evolution of some plant or animal he is expressing the rancour and animosity which he feels towards those folk (now few among the intelligent) who fancy evolution in some way inconsistent with doctrines dear to them, or that when I speak of the tens of millions of years of which the crust (God's work, and therefore His word) tells us, that I want to hurt the feelings of those who find a few thousand years of work as much as they can believe God capable of? So when Mr. Clodd speaks of the origin of myths, or Mr. Foster speaks of what the Spencerian school holds (and I think rightly) to be the origin and true meaning of moral laws, can you for a moment imagine that they are moved by feelings of ill-will towards those who think, or think they think, such ideas must be erroneous (let the evidence be what it may)? *When* we feel so, some system of reconciliation such as you suggest may be wanted. But it will, I fancy, be a long time first. When you speak of "determined, indeed bitter, opposition" where we are, in truth, absolutely unconcerned, you remind me of the way in which some school-girls quarrel, who, when annoyed by perfect coolness, pretend to see fierce anger. "You needn't get angry, dear," they will say; "your hair's coming out of curl." Allow me to assure you we are not troubled by the anger you imagine: our hair curls quite sweetly still.—S. GRIFFIN. The advantages claimed for the Christy over the Amici have no real existence, though claimed—Paul gets what is taken from Peter.—W. D. B. I said each star had been seen with a telescope 2½ in. in aperture, not that such a telescope would show such regions as appeared in my maps with all those stars simultaneously visible. The chart results from picturing in a single view the stars seen when such a telescope is laboriously directed to part after part of the heavens.—E. RATCLIFF. I would gladly answer if I knew, but I do not know, whether condensed sea-water (meaning, I suppose, distilled) is used on board any vessels for drinking purposes.—E. ANDERSON. I quite agree with you. The system may be *necessary* for many, as in the training of children. Those I have learned to love and esteem most of all whom, thus far in my life, I have known, have been absolutely free from both the fears and the hopes to which you refer. But many doubt whether that state of mind is possible or even conceivable. The passage you quote is indeed absurd—but the reporter may be in fault. "No telescope can show God!" No; nor can the conscience be analysed in a laboratory, or the soul investigated with a microscope. But he might with equal sense have said (to use Sydney Smith's illustration of nonsense) that you can't "ride to London on a pound of pickled salmon."—ENQUIRER. I know nothing of the rules relating to debts of honour, absurdly so called. I am sorry to learn that so fine a game as whist should ever be played for stakes large enough to be worth troubling about.—C. E. HANSON. No not like the moon; that stage would be a far later one. But the earth would become entirely water covered through the washing away of all her upraised portions, were it not for subterranean action renewing the inequalities of level. The disappearance of water would, much later, be brought about by the gradual withdrawal of the seas into porous cavities in the cooled crust and nuclear regions.—OMEGA. Thanks. I try to please as many as possible,—a Spencerian system on a small scale.—G. M. Nearly always, when a communication is not acknowledged in this part of KNOWLEDGE, it may be taken for granted that it has been marked for insertion. But sometimes considerable delay intervenes between this and the appearance of the letter. It should be clear to you, however, that there could not have been any idea of annoying you, in any case. Look at my lecture advertisements and you will (or should) be prepared to understand and forgive occasional delays.—STEAM ROLLER. You are right; there must be continual, though slight, sliding: this is no doubt intended.—R. W. J. It seems likely enough that in a number of cases the cure was a mere coincidence; but there are so many much more remarkable illustrations of the influence of the mind on the body that we must take that into account.—CHAS. A. EDES. Many thanks for your very curious and interesting work on "Papyrography," which I hope shortly to "notice."

Our Mathematical Column.

THE PHILOSOPHY OF MATHEMATICS.*

BY PROFESSOR A. CAYLEY.

IN TWO PARTS.—PART II.

(*Continued from page* 205.)

IT is interesting to consider two different ways in which, without any modification at all of our notion of space, we can arrive at a system of non-Euclidian (plane or two dimensional) geometry; and the doing so will, I think, throw some light on the whole question.

First, imagine the earth a perfectly smooth sphere; understand by a plane the surface of the earth, and by a line the apparently straight line (in fact an arc of great circle) drawn on the surface; what experience would in the first instance teach would be Euclidian geometry; there would be intersecting lines which, produced a few miles or so, would seem to go on diverging; and apparently parallel lines which would exhibit no tendency to approach each other; and the inhabitants might very well conceive that they had by experience established the axiom that two straight lines cannot enclose a space, and the axiom as to parallel lines. A more extended experience and more accurate measurements would teach them that the axioms were each of them false; and that any two lines, if produced far enough each way, would meet in two points; they would, in fact, arrive at a spherical geometry, accurately representing the properties of the two-dimensional space of their experience. But their original Euclidian geometry would not the less be a true system; only it would apply to an ideal space, not the space of their experience.

Secondly, consider an ordinary, indefinitely extended plane; and let us modify only the notion of distance. We measure distance, say, by a yard measure or a foot rule,

* Abstract of that portion of Professor Cayley's Address before the British Association at Southport which relates to the philosophy of Mathematics and to certain recent ideas respecting non-Euclidian Geometry and space of more than three dimensions.

anything which is short enough to make the fractions of it of no consequence (in mathematical language by aninfinitesimal element of length); imagine, then, the length of this rule constantly changing (as it might do by an alteration of temperature), but under the condition that its actual length shall depend only on its situation on the plane and on its direction—viz., if for a given situation and direction it has a certain length, then whenever it comes back to the same situation and direction it must have the same length. The distance along a given straight or curved line between any two points could then be measured in the ordinary manner with this rule, and would have a perfectly determinate value; it could be measured over and over again, and would always be the same; but of course it would be the distance, not in the ordinary acceptation of the term, but in quite a different acceptation. Or in a somewhat different way; if the rate of progress from a given point in a given direction be conceived as depending only on the configuration of the ground, and the distance along a given path between any two points thereof be measured by the time required for traversing it, then in this way also the distance would have a perfectly determinate value; but it would be a distance, not in the ordinary acceptation of the term, but in quite a different acceptation. And corresponding to the new notion of distance we should have a new, non-Euclidian system of plane geometry; all theorems involving the notion of distance would be altered.

We may proceed further. Suppose that as the rule moves away from a fixed central point of the plane it becomes shorter and shorter; if this shortening takes place with sufficient rapidity, it may very well be that a distance which in the ordinary sense of the word is finite will in the new sense be infinite; no number of repetitions of the length of the ever-shortening rule will be sufficient to cover it. There will be surrounding the central point a certain finite area such that (in the new acceptation of the term distance) each point of the boundary thereof will be at an infinite distance from the central point; the points outside this area you cannot by any means arrive at with your rule; they will form a *terra incognita*, or rather an unknowable land; in mathematical language, an imaginary or impossible space; and the plane space of the theory will be that within the finite area—that is, it will be finite instead of infinite. We thus with a proper law of shortening arrive at a system of non-Euclidian geometry which is essentially that of Lobatschewsky. But in so obtaining it we put out of sight its relation to spherical geometry; the three geometries (spherical, Euclidian, and Lobatschewsky's) should be regarded as members of a system—viz., they are the geometries of a plane (two-dimensional) space of constant positive curvature, zero curvature, and constant negative curvature respectively; or again they are the plane geometries corresponding to three different notions of distance; in this point of view they are Klein's elliptic, parabolic, and hyperbolic geometries respectively.

Next, as regards solid geometry, we can by a modification of the notion of distance (such as has just been explained in regard to Lobatschewsky's system) pass from our present system to a non-Euclidian system; for the other mode of passing to a non-Euclidian system it would be necessary to regard our space as a flat three-dimensional space existing in a space of four dimensions (*i.e.*, as the analogue of a plane existing in ordinary space); and to substitute for such flat three-dimensional space a curved three-dimensional space, say of constant positive or negative curvature.

In regarding the physical space of our experience as possibly non-Euclidian, Riemann's idea seems to be that of modifying the notion of distance, not that of treating it as a locus in four-dimensional space.

I have just come to speak of four-dimensional space. What meaning do we attach to it? Or can we attach to it any meaning? It may be at once admitted that we cannot conceive of a fourth dimension of space; the space as we conceive of it, and the physical space of our experience, are alike three-dimensional; but we can, I think, conceive of space as being two or even one-dimensional; we can imagine rational beings living in a one-dimensional space (a line) or in a two-dimensional space (a surface) and conceiving of space accordingly, and to whom, therefore, a two-dimensional space, or (as the case may be) a three-dimensional space would be as inconceivable as a four-dimensional space is to us. And very curious speculative questions arise. Suppose the one-dimensional space a right line, and that it afterwards becomes a curved line; would there be any indication of the change? Or, if originally a curved line, would there be anything to suggest to them that it was not a right line? Probably not, for a one-dimensional geometry hardly exists.

But let the space be two-dimensional, and imagine it originally a plane and afterwards bent (converted, that is, into some form of developable surface) or converted into a curved surface; or imagine it originally a developable or curved surface. In the former case there should be an indication of the change, for the geometry originally applicable to the space of their experience (our own Euclidian geometry) would cease to be applicable; but the change could not be apprehended by them as a bending or deformation of the plane, for this would imply the notion of a three-dimensional space in which this bending or deformation could take place. In the latter case their geometry would be that appropriate to the developable or curved surface which is their space—viz., this would be their Euclidian geometry; would they ever have arrived at our more simple system?

But take the case where the two-dimensional space is a plane, and imagine the beings of such a space familiar with our own Euclidian plane geometry; if, a third dimension being still inconceivable by them, they were by their geometry or otherwise led to the notion of it, there would be nothing to prevent them from forming a science such as our own science of three-dimensional geometry.

Evidently all the foregoing questions present themselves in regard to ourselves, and to three-dimensional space as we conceive of it, and as the physical space of our experience. And I need hardly say that the first step is the difficulty, and that granting a fourth dimension we may assume as many more dimensions as we please. But whatever answer be given to them, we have, as a branch of mathematics, potentially, if not actually, an analytical geometry of n-dimensional space.

Coming now to the fundamental notion already referred to, that of imaginary magnitude in analysis and imaginary space in geometry, I connect this with two great discoveries in mathematics made in the first half of the seventeenth century, Harriot's representation of an equation in the form $f(x) = 0$, and the consequent notion of the roots of an equation as derived from the linear factors of $f(x)$, and Descartes' method of co-ordinates, as given in the "Géometrie." By these we are led analytically to the notion of imaginary points in geometry; for instance, we arrive at the theorem that a straight line and a circle in the same plane intersect always in two points, real or imaginary. The conclusion as to the two points of intersection cannot be contradicted by experience; take a sheet of paper and draw on it the straight line and circle, and

try. But you might say, or at least be strongly tempted to say, that it is meaningless.

The question, of course, arises, What is the meaning of an imaginary point? and further, In what manner can the notion be arrived at geometrically? There is a well-known construction in perspective for drawing lines through the intersection of two lines, which are so nearly parallel as not to meet within the limits of the sheet of paper. You have two given lines which do not meet, and you draw a third line, which, when the lines are all of them produced, is found to pass through the intersection of the given lines. If instead of lines we have two circular arcs not meeting each other, then we can, by means of these arcs, construct a line; and if on completing the circles it is found that the circles intersect each other in two real points, then it will be found that the line passes through these two points; if the circles appear not to intersect, then the line will appear not to intersect either of the circles. But the geometrical construction being in each case the same, we say that in the second case also the line passes through the two intersections of the circles. Of course, it may be said in reply that the conclusion is a very natural one, provided we assume the existence of imaginary points; and that, this assumption not being made, then, if the circles do not intersect, it is meaningless to assert that the line passes through their points of intersection. The difficulty is got over by the analytical method before referred to, for this introduces difficulties of its own; is there in a plane a point the co-ordinates of which have given imaginary values? As a matter of fact, we do not consider in plane geometry imaginary points introduced into the theory analytically or geometrically as above. The like considerations apply to solid geometry, and we thus arrive at the notion of imaginary space as a *locus in quo* of imaginary points and figures.

I have used the word imaginary rather than complex, and I repeat that the word has been used as including real. But, this once understood, the word becomes in many cases superfluous, and the use of it would even be misleading. Thus, "a problem has so many solutions;" this means, so many imaginary (including real) solutions. But if it were said that the problem had "so many imaginary solutions," the word "imaginary" would be here understood to be used in opposition to real. I give this explanation the better to point out how wide the application of the notion of the imaginary is—viz. (unless expressly or by implication excluded), it is a notion implied and presupposed in all the conclusions of modern analysis and geometry. It is, as I have said, the fundamental notion underlying and pervading the whole of these branches of mathematical science.

In geometry it is the curve, whether defined by means of its equation, or in any other manner, which is the subject for contemplation and study. But we also use the curve as a representation of its equation—that is of the relation existing between two magnitudes x, y, which are taken as the co-ordinates of a point on the curve. Such employment of a curve for all sorts of purposes—the fluctuations of the barometer, the Cambridge boat-races, or the Funds—is familiar to most of you.

It is in like manner convenient in analysis for exhibiting the relations between any three magnitudes, x, y, z, to regard them as the co-ordinates of a point in space; and, on the like ground, we should at least wish to regard any four or more magnitudes as the co-ordinates of a point in space of a corresponding number of dimensions. Starting with the hypothesis of such a space, and of points therein each determined by means of its co-ordinates, it is found possible to establish a system of n-dimensional geometry analogous in every respect to our two- and three-dimensional geometries, and to a very considerable extent serving to exhibit the relations of the variables. It is to be borne in mind that the space, whatever its dimensionality may be, must always be regarded as an imaginary or complex space such as the two- or three-dimensional space of ordinary geometry; the advantages of the representation would otherwise altogether fail to be obtained.

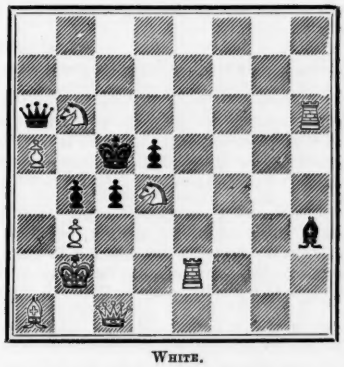
Our Chess Column.

By Mephisto.

PROBLEM No. 103.

By E. N. Frankenstein.

Black.



White.

White to play and self-mate in 5 moves.

(A very ingenious conception.—Ed.)

Solution.—Problem No. 102, p. 250.

1. Kt to Kt sq	Kt to B6 (ch), or 1.		Kt to B8
2. B takes Kt	Kt to Kt3 (ch)	2. B to B7	P to R3
3. K to K6	K to K5	3. B to Q8	any move
4. R to K2 mate		mates accordingly	

Members of the fairer sex have a more sensitive and complex nervous system, rendering them more susceptible to mental influence than their less gifted masculine fellow-creatures. Hence, in accordance with the theory advanced in our recent article on the subject of mind influence, the Chess play of ladies would be more inclined to vary through this influence than that of men. The idea is certainly supported by the fact that we have not many strong lady Chess players. We will not, however, now examine whether this disadvantage only forms the minor obstacle to success, or whether the want of perseverance and powers of concentration of thought, are the real causes of failure in feminine Chess practice. We will chivalrously assume the former to be the major and not the minor obstacle, especially as it may be possible that a too extensive practice of Chess playing amongst ladies would result to the disadvantage of us men.

Notwithstanding, a little more attention might be given by ladies to our noble game; for only in this wise can the earnest ideal of Mr. Lamb, the President of the North London Chess Club, be realised. At the recent very successful annual dinner of the North London Chess Club, the worthy President expressed it as his sincere conviction that Chess ought to be taught to the young. "Chess strengthens the intellect," he remarked, "induces cautious habits and steadiness, and is likely to keep the superabundant spirit of youth within bounds, besides initiating the child in a recreation which if indulged in moderately would be a constant source of pleasure in after-life." Who is there, we ask, more fit to teach Chess to the young than ladies?

To assist such of our fair readers as wish to gain a good insight into the subtleties of Chess, we will this week enter more fully than

usual into the spirit of a game, by analytically explaining every move.

1. P to K4

There are also other ways of opening a game besides P to K4, as, for example, KKt to KB3 or P to Q4, P to QB4, P to KB4, &c. P to K4 is the more general, and usually leads to an open game, most suitable for beginners. The other first moves enumerated mostly lead to close games, requiring a close reasoning and a subtlety in play suitable to more advanced players.

1. P to K4.

P to K3, called the French defence, may also be played, but it likewise leads to a close game. The main object in a game is to capture the King; this is facilitated by capturing your opponent's pieces, to do which you must occupy the most favourable positions for attack. P to K4, besides commanding two centre squares, favours the development of the pieces, a very important point. It liberates the Queen and Bishop.

2. KKt to KB3.

It is always a gain of time to develop a piece by attacking one of your opponent's pieces, in this case the King's Pawn. Black must defend this, which gives time for another developing move. The King's Knight and King's Bishop are played early in the game to enable castling, which brings the King into safety by being more out of the reach of the hostile pieces, therewith also giving more freedom for attack.

2. QKt to QB3

Protects the King's Pawn by bringing a piece into play. This move is decidedly better than to defend the King's Pawn by (*a*) P to Q3; this prevents the King's Bishop from getting into good play, and therefore retards castling, which is unfavourable to the development of Black's game. (*b*) P to KB3 is not good, as a rule, early in the game, as the Queen has command of the square on KR5. For instance, if Black plays 2. P to KB3, White can sacrifice the Knight with 3. Kt takes KP; if Black then replies 3. BP takes Kt, White will play 4. Q to KR5 check, 4. P to Kt3. 5. Q takes KP check, 5. K to B2, 6. Q takes KR, winning. (*c*) 2. B to Q3 is very bad, because it blocks the Queen's Pawn, and thus prevents the Queen's Bishop from coming into play, besides restricting the action of the King's Bishop. 2. Q to K2 blocks the King's Bishop, and 2. Q to KB3 is not good, because it is advisable to develop the minor pieces before bringing the Queen into play. 2. KKt to KB3 is also possible, for although it does not defend the King's Pawn, it is a counter attack on the White King's Pawn; but this leads to a complicated game.

3. KB to QB4.

The King's Bishop's Pawn is weak, as it is only defended by the King, and may also be attacked by Kt to Kt5, Q to B3, &c.

3. KB to QB4.

The best move. If, for example, 3. KKt to B3, which constitutes the two Knights' Defence, instead of KB to QB4, then White can at once attack the King's Bishop's Pawn by playing KKt to Kt5. The Pawn can only be defended with some inconvenience by Black, who has to play P to Q4, and temporarily abandon the Queen's Pawn in defence of the KBP.

4. P to QB3.

Threatening to play P to Q4, and obtain a commanding position with his two centre Pawns, besides shutting off the Black Bishop from the weak spot on KB7. This continuation is called the Giuoco Piano. Other good continuations are either 4. Castles, or 4. P to Q3.

4. KKt to KB3.

This is recognised as the best defence in this position, as it attacks the White King's Pawn. It is better than 4. P to Q3, to which White could reply with 5. P to Q4, attacking the King's Bishop, and threatening to play KKt to Kt5. 4. Q to K2 is also less favourable to the development of Black's game.

5. KKt to Kt5.

At attacking move, but, as Black is enabled to Castle, the move ought not to avail against good play.

5. Castles.

The best move to defend the King's Bishop's Pawn.

6. P to Q3.

Defending his King's Pawn against the Black Knight, in case the White Knight on Kt5 should be compelled to retire, and also liberating his Queen's Bishop.

6. P to KR3.

With the intention of forcing the White Knight to retire, in which case, of course, White's move of 5. KKt to Kt5 would merely have been time wasted.

7. P to KR4.

White abandons the Knight, as he hopes to be compensated for the sacrifice by obtaining command of the Rook's file for his Queen, supported by the Rook, by playing Q to R5, which would threaten mate.

7. P takes Kt.

A very injudicious capture. Black here ought to play 7. P to Q3, instead of P takes Kt, for, after 7. P to Q3, it would be safe for Black to play 8. P takes Kt, for Black would immediately follow this up by 9. QB to KKt5, attacking the Queen and preventing her from playing to the desired spot on QR5. Of course, if Black plays 7. P to Q3, White can retire his Knight from Kt5, but Black would remain with a superior development.

8. P takes P.

Attacking the Knight and threatening Q to R5.

8. KKt to KR2.

This allows the dangerous move of Q to R5 to be played. Black would have done better for the present if he had played P to KKt3, abandoning the Knight at once, but preventing the fatal Q to R5.

9. Q to R5.

Threatening Q takes Kt mate.

9. KR to K sq.

This makes room for the King. Black had nothing else to defend the mate; the KBP, of course, cannot move, as it is pinned by the white Bishop.

10. Q takes BP check.

As will be seen, this move brings about a pretty mate in three moves, and is, therefore, superior to Q takes Kt, in which case the mate would be delayed.

10. K to R sq.

11. R takes Kt check. 11. K takes R.

12. Q to R5 mate.

[P. 235]—I was much pleased with the paper on the influence of mind over mind in chess play. In my opinion, a *very slow* player frequently throws his opponent into a kind of stupor or somnolent state, in which he is really almost unconscious of the move he is making—oftentimes a very bad one indeed—a surprise to himself and every one else.—JOHN.

ANSWERS TO CORRESPONDENTS.

*** *Please address Chess Editor.*

Alpha.—A Pawn cannot take a piece en passant.

G. R. M.—Mr. Cook, Birmingham Chess Club.

H. Twinner.—Game received, with thanks.

Walter Waring.—Problem received, with thanks; will be examined.

Correct solutions received.—Problem 102, Henry Bristow, M. T. Hooton.

All the Tourney Problems have been correctly solved by W. and Clarence. Good solvers think them below the average of good Tourney Problems.

Correction.—In the Two-mover Emu the Kt on White K sq is a Black Knight.

CONTENTS OF No. 104.

	PAGE
A Naturalist's Year. Chestnuts Fall. By Grant Allen	251
How to Get Strong	252
The Chemistry of Cookery. XXI. By W. Mattieu Williams	253
The Morality of Happiness. By Thomas Foster	254
The Fisheries Exhibition. VIII. By John Ernest Ady	255
The Sun's Distance. By Professor R. S. Ball, LL.D.	257
Nights with a Three-Inch Telescope. (*Illus.*)	258
Sea Anemones. VII.—The Parasite. (*Illus.*) By T. Kimber	259
Tricycles in 1883	260
The Face of the Sky. By F.R.A.S.	261
Correspondence: The Barn Owl—Palæolithic Man—Property of Numbers, &c.	261
Our Whist Column	265
Our Chess Column	266

SPECIAL NOTICES.

Part XXIV. (October, 1883), now ready, price 10d., post-free, 1s. 1d.

Volume III., comprising the numbers published from January to June, 1883, now ready, price 7s. 6d.

The Title Page and Index to Volume III. also ready, price 2d., post-free, 2½d.

Binding Cases for Volume III., price 2s. each. Including carriage per Parcels Post to any address in the United Kingdom, 2s. 3d. Subscribers' numbers bound (including Title, Index, and Case) for 3s. each., 6d. extra for carriage for return journey per Parcels Post.

P. O. Orders and cheques should be made payable to the Publishers, MESSRS. WYMAN & SONS, London, at the High Holborn District Post-office.

Agent for America—C. S. Carter, American Literary Bureau, Tribune Buildings, New York, to whom subscriptions can be forwarded.

TERMS OF SUBSCRIPTION.

The terms of Annual Subscription to the weekly numbers of KNOWLEDGE are as follows:—

	s.	d.
To any address in the United Kingdom	10	10
To the Continent, Australia, New Zealand, South Africa & Canada	13	0
To the United States of America	$3.25. or 13	0
To the East Indies, China, &c. (*vid* Brindisi)	15	2

All subscriptions are payable in advance.

OFFICE : 74-76, GREAT QUEEN STREET, LONDON, W.C.